WSTIAC

Weapon Systems Technology Information Analysis Center

TECHNOLOGY TRANSFER

Advancing Warfighting Capabilities

The AC-130: Gunships Unleashed

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14. ABSTRACT
This issue of the WSTIAC Quarterly features articles on Advancing Warfighting Capabilities through Technology Transfer and Iraq and the AC-130 Gunship Unleashed. Included the WSTIAC Calendar of Events and the Directors Corner. Details on several Training Courses sponsored by WSTIAC are also included in this issue.

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INTRODUCING THE NEW WSTIAC DIRECTOR

It is my distinct pleasure and honor to introduce Mr. John Weed as the new Director of WSTIAC. Mr. Weed joins WSTIAC after retiring as a Colonel from the US Army, while serving a distinguished thirty year combined career in both the Army and the defense industry. During his diverse career, Mr. Weed gained valuable and varied experience with weapon systems across the services from aviation to ammunition. He has supervised and personally worked on many aspects of weapon systems technologies including interoperability, supportability, design, testing, hardware and software integration, and modeling/simulation.

During his final assignment for the US Army, Mr. Weed was responsible for co-management of a $38.0M+ Joint Capability Technology Demonstration (JCTD) at the Armament Research, Development and Engineering Center (ARDEC) in Picatinny, NJ. This position included the development and execution of the DoD acquisition strategy for the Joint Modular Intermodal Distribution System (JMIDS), which is a new, modular logistics distribution technology demonstration system for the DoD. He also interfaced with the DoD Research and Development and Joint Acquisition communities, including the Program Executive Office (PEO) Ammunition (supporting all direct, indirect fire, and close combat weapon systems), PEO Combat Support / Combat Support Systems (CS/CSS).

During his career in the defense industry, Mr. Weed has served in a number of capacities, including applications engineer, applications engineering manager, scientist, senior program manager, and most recently division manager and assistant vice president with Alion Science and Technology. His extensive expertise in several areas is the direct result of his academic credentials. Mr. Weed holds a BA in Natural Science/Economics from Claremont McKenna College, a MS in Systems Management from the University of Southern California, a MS in Environmental Engineering Sciences from Indiana University, and a MS in Strategic Studies from the US Army War College. He also has completed the PhD coursework in Environmental and Resources Engineering. Mr. Weed's professional career has allowed him the opportunity to be involved in several technology areas as a program manager, engineer and scientist.

These technologies include remote sensing systems; global positioning systems; auxiliary power unit systems for Blackhawk and Apache helicopters; environmental control, primary and auxiliary power, and avionics systems for the A4 and F-16 aircraft platforms; radar systems for 60-120 mm mortars and 105-155 mm howitzers; position/navigation system electronics for armored vehicle systems; and sensor hardware and software integration and deployment.

Mr. Weed is a qualified Army Acquisition Corps Officer, a Lean Six Sigma Green Belt, and is certified in Capability Maturity Model Integration (CMMI) for training and qualifications. He also has received several awards from his military service including the Legion of Merit, Meritorious Service Medal, Army Commendation Medal, Army Achievement Medal, and GWOT Service Medal.

In future editions of the *WSTIAC Quarterly*, Mr. Weed will introduce the issue with a message to the readers as he has for this issue. In the meantime, I encourage you to welcome Mr. Weed to his new position.

Ben Craig, Editor

A MESSAGE FROM JOHN WEED, WSTIAC DIRECTOR

I look forward to addressing the weapon systems technology community in future issues of this journal. With high expectations, I will be focusing my efforts to continue to improve the already strong WSTIAC program, and establish some new and innovative ways to support the broader customer base.

Director's Corner

In this issue of the *WSTIAC Quarterly* you will find a valuable article that describes how the Department of Defense promotes technology transfer between DoD agencies and private industry. The article explains the two primary mechanisms which DoD uses for technology transfer, and provides an example of a technology that was rapidly and cost-effectively transitioned to the warfighter. The second article highlights some of the special capabilities of the AC-130 gunship from an experienced pilot's perspective. I hope these articles will prove to be useful in your continued efforts to support our warfighters.

John Weed, WSTIAC Director

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Advanced Warfighting Capabilities through Technology Transfer

Will Swearingen
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Technology transfer (T2) is one of the most important ways that DoD acquires innovative technology for the US warfighter. Through T2, DoD is able to leverage the innovativeness, rapid-response capabilities, and financial resources of the private sector. In addition, T2 provides a key way for DoD to benefit from the innovations developed in its own network of research and development (R&D) labs nationwide.

This article first examines the background for DoD's use of technology transfer. Next, it reviews the major T2 mechanisms used by DoD. It subsequently discusses DoD's successful use of outside "partnership intermediaries" to facilitate T2 with the private sector. Finally, it provides an example of how, through T2, the US warfighter in Iraq and Afghanistan is benefiting today from advanced rangefinding and target acquisition capabilities.

BACKGROUND

Technology transfer, in the simplest terms, is the exchange of technology between the public and private sectors. This exchange can flow from either a DoD lab to a company (*spin-off*) or vice versa (*spin-on*). Alternatively, new technology can be collaboratively developed by a DoD lab and a company for their respective applications (*dual-use technology development*). However it occurs, technology transfer clearly assists DoD with its defense mission.

> Domestic T2 activities are integral elements of DoD pursuit of the DoD national security mission and concurrently improve the economic, environmental, and social well-being of US citizens. Concurrently, T2 supports a strong industrial base that the Department of Defense may utilize to supply DoD needs. Those activities must have a high-priority role in all DoD acquisition programs...
> –Department of Defense Directive, 1999

The prevailing guidance for DoD technology transfer was summarized in a 1999 Department of Defense Directive: "Domestic T2 activities are integral elements of DoD pursuit of the DoD national security mission and concurrently improve the economic, environmental, and social well-being of US citizens. Concurrently, T2 supports a strong industrial base that the Department of Defense may utilize to supply DoD needs. Those activities must have a high-priority role in all DoD acquisition programs and are recognized as a key activity of the DoD laboratories and all other DoD activities (such as test, logistics, and product centers and depots and arsenals) that may make use of or contribute to domestic T2".[1]

This policy directive implicitly acknowledged a major paradigm shift in internal DoD thinking about its defense mission following the end of the Cold War. It also was a response to major new technological, budgetary, and political realities.[2] Formerly, DoD essentially considered technology transfer to be a by-product of its R&D. Its R&D was well-funded and DoD was at the forefront of technological advancement. Much of its cutting-edge technology was not readily available to the private sector. By the mid-1990s, however, DoD-developed technology in many militarily critical fields was no longer more advanced than private-sector technology. In addition, DoD anticipated a steady decline in R&D funding. Finally, DoD faced pressure by Congress to ensure that technology developed for the defense mission was made available to the private sector to enhance the national industrial base, stimulate the economy, improve taxpayer quality of life, and contribute to US economic competitiveness.[3]

For the above reasons, by the mid-1990s, DoD's top leaders embraced the concept of technology transfer. From the defense-mission perspective, technology transfer came to be seen as a way to share R&D costs with the private sector, gain access to leading-edge innovations, harness the efficiency of the private sector in converting new technology into products, reduce technology acquisition costs by benefiting from economies of scale (where dual-use technology had a sizeable commercial market), and maintain the US military's global technological advantage.[2,4]

TECHNOLOGY TRANSFER MECHANISMS

The two primary mechanisms used by DoD for technology transfer are cooperative research and development agreements (CRADAs) and patent licensing agreements. CRADAs enable DoD to collaborate with industry to jointly research and develop technologies that have both military and commercial applications. All federal laboratories were given authority to enter into CRADAs with industry by the Federal Technology Transfer Act of 1986.[5] CRADAs clearly spell out the rules of engagement, protect existing intellectual property of the collaborating parties, and provide for equitable allocation of any new inventions resulting from CRADA projects. They are by far the most common technology transfer vehicle used by DoD.

> CRADAs enable DoD to collaborate with industry to jointly research and develop technologies that have both military and commercial applications.

CRADAs are viewed by DoD as having the following distinct benefits:

- Reduce the cost of new technology development
- Leverage the innovativeness of the US private sector
- Enable DoD to gain access to new technology developments to meet its mission requirements
- Strengthen the capability of the US industrial base to support the defense mission
- Foster early-stage research with the potential to lead to future militarily critical technology
- Accelerate technology development

In addition, companies often bring funding to the DoD laboratory to further develop technology under a CRADA, which helps defray the costs of DoD lab R&D.[2,3]

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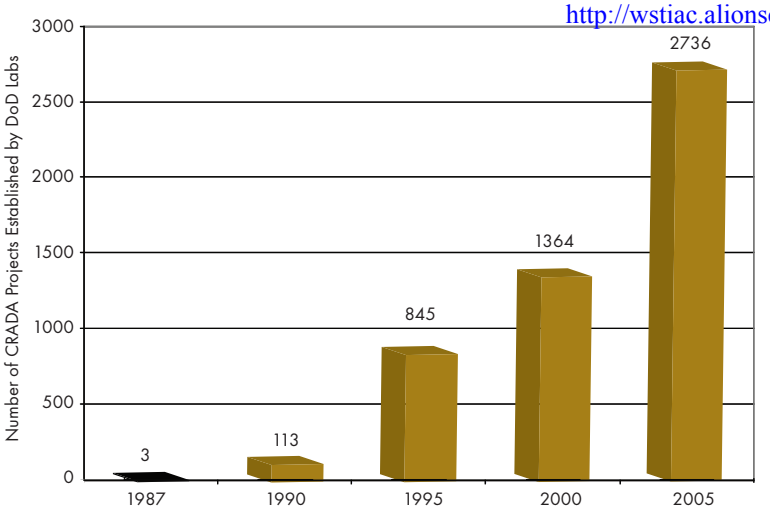

Figure 1. The Number of CRADAs in the DoD lab system has grown dramatically.

Clearly, the use of CRADAs by DoD to promote technology transfer has been highly successful. Following granting of CRADA authority, the number of CRADA projects established by DoD labs has grown dramatically (Figure 1). Total active CRADAs in the DoD lab system grew from three in fiscal year (FY) 1987 to 113 in FY 1990, 845 in FY 1995, 1,364 in FY 2000, and 2,736 in FY 2005.[6,7] DoD labs establish far more CRADAs than any other federal agency and account for approximately half of all active federal lab CRADAs. By contrast, the federal agency in second place, the Department of Energy (DOE), accounts for about a fourth of all active CRADAs [3].

Licensing agreements are the main mechanism by which patented and patent-pending inventions developed by DoD are transferred to the private sector for commercialization and subsequent transition to DoD use.[3] The Federal Technology Transfer Act of 1986 authorized directors of federal laboratories to engage in licensing agreements and stimulated the licensing of federal government patents by authorizing federal labs to retain licensing royalties and to share a portion of these royalties with government inventors.[5]

Licensing agreements are the main mechanism by which patented and patent-pending inventions developed by DoD are transferred to the private sector for commercialization and subsequent transition to DoD use.

The nationwide network of approximately 120 DoD RDT&E sites generates significant numbers of new inventions each year in virtually all major technology fields. These fields include:

- Advanced materials
- Aerospace
- Biomedicine
- Communications
- Electronics
- Environmental technology
- Photonics
- Sensors
- Software

DoD researchers disclose well over 1,200 new inventions each year, leading to around 800 patent applications and from 400 to 600 issued patents per year.[7] DoD leads all US federal agencies in patenting.[8]

Despite its premier position in the US federal government in patenting, DoD falls behind other major research agencies – such as DOE and Health and Human Services (which includes the National Institutes of Health) – in transferring its technologies to the private sector through licensing agreements.[8] In part, this is directly related to the limited commercial potential of many DoD patents. A large percentage of DoD patents have claims specific to military technology such as artillery, submarines, and missile guidance systems, which are important for military use but often lack commercial market potential.

In addition, lower licensing rates reflect the singular nature of DoD R&D and technology transfer. DoD is a unique federal agency because it is the primary (often the exclusive) customer of the technology being developed in its labs or under its contracts. Other federal agencies develop new technology primarily for use by the US private sector or general public. Industry does not need a license to manufacture DoD-owned technology for DoD or other US federal agencies. Such licenses are needed only to manufacture or use DoD-owned technology for private-sector, other US public sector, or foreign military markets. This reduces the number of DoD licensing agreements. A final factor reducing the number of DoD licensing agreements is the fact that some DoD technology is military sensitive.

For the reasons above, DoD's licensing metrics have not experienced the same dramatic increase as its CRADA metrics since passage of the Federal Technology Transfer Act in 1986. The number of active licensing agreements grew from ten in FY 1987 to 196 in FY 1999 and 446 in FY 2007.[4,6,9] (Many of these licensing agreements include multiple patents).

DoD's Office of Technology Transition (OTT), which oversees the agency's T2 activities, has placed a major emphasis on increasing the number of licensing agreements with industry as a way to close the loop between DoD technology development and the transition of innovative technology to the US warfighter. Licensing DoD innovations to industry is viewed favorably because the private sector is the critical link in converting new technology into products, which the US military can then purchase.

DoD's Office of Technology Transition oversees the agency's technology transfer activities.

In addition, licensing enables DoD to benefit from the private sector's investment in the final stages of technology development as well as from economies of scale in cases where the technology has both military and non-military applications. These economies of scale help drive down the cost of technology acquisition. Finally, licensing of DoD-developed technologies for commercial applications brings in fees and royalties to the DoD labs, which can be used to undertake additional R&D and reward inventors.

DOD PARTNERSHIP INTERMEDIARIES

One of the key ways that OTT is attempting to increase DoD licensing to industry is through the use of "partnership intermediaries". Partnership intermediaries (PIs) are state government, local government, or non-profit organizations that promote technology transfer between federal labs and the private sector. Authorization for the use of PIs dates back to the American Technology Preeminence Act of 1991. While the authorizing legislation is applicable to all federal agencies, only DoD has made extensive use of PIs. The majority of PIs established to date have been associated with specific DoD laboratories and have emphasized technology transfer to foster local or regional economic development.[3]

In 1999, DoD established its first agency-wide PI agreement with an existing federal technology transfer center at Montana

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State University called TechLink. TechLink originally had been established in 1996 to broker technology transfer agreements between NASA and industry in its region. Based on its success, it was funded in 1999 to establish a "Defense TechLink" program.

Defense TechLink is overseen by the OTT, with its contract managed through the Air Force Research Laboratory (AFRL) headquartered at Wright-Patterson Air Force Base (AFB) in Dayton, Ohio. Unlike previous PIs, TechLink was mandated to establish technology transfer partnerships across the entire DoD lab system, including the Army, Navy, Air Force, and DoD Agencies such as the National Security Agency.

Defense TechLink initially concentrated on increasing DoD technology transfer with companies in the northwestern United States. In 2001, however, OTT tasked it with increasing the number of DoD licensing agreements with industry. Due to this new emphasis, TechLink broadened its geographic focus for licensing of DoD technologies to the United States as a whole.[7] To support this licensing focus, TechLink developed a multi-step process that included:

1) Screening of *all* DoD-issued patents and published patent applications for technology transfer potential, using the following criteria: technology readiness level, innovativeness of the technology, strength of the patent claims, and commercial viability.
2) Selection of a portfolio of DoD technologies for active marketing to industry.
3) Engaging in highly focused marketing to industry by directly contacting companies identified as promising candidates through background research.
4) Helping companies interested in licensing DoD technologies in the following key ways: evaluating the technology for their intended applications, understanding government licensing regulations and DoD lab requirements, and assisting in preparing high-quality license applications, including commercialization plans.
5) Remaining involved through the license negotiation and finalization phases to facilitate communications between the DoD lab and the company and to help resolve problems that might arise.
6) Helping to broker related CRADAs between DoD labs and companies where appropriate – for example, to enable the licensee to draw on the expertise of the DoD inventor and DoD to benefit from company improvements to the technology.[3]

TechLink's shift to a DoD licensing focus in 2001 led to a rapid increase in licensing metrics. The number of TechLink-facilitated licensing agreements grew from three in FY 2001 to 31 in FY 2007.[10] Concurrently, the overall number of new DoD licensing agreements increased from an average of 33 per year during the FY 1998-1999 period to 60 per year by the FY 2006-2007 period.[9] In FY 2007, TechLink facilitated almost half of all DoD licensing agreements with industry nationwide – 31 out of 63 total agreements.

TechLink currently is the only agency-wide PI that is directly funded from the DoD budget. However, since 2003, four other DoD-wide PIs have been created with funding from "earmarked" Congressional appropriations. Each has a distinctive focus. FirstLink, in Pittsburgh, Pennsylvania, helps to commercialize DoD technologies for first responder and homeland security applications; DoD TechMatch, in Fairmont, West Virginia, facilitates DoD technology transfer by providing an Internet portal to information on DoD labs, DoD technologies, technology needs, R&D opportunities, and technology transfer successes; SpringBoard, in Juneau, Alaska, promotes technology transfer partnerships between DoD labs and Alaskan companies; and T2Bridge, in Columbia, South Carolina, focuses on technology transfer between DoD and companies in the southeastern United States. Like TechLink, all of these agency-wide PIs are overseen by DoD's OTT, with their contracts managed by AFRL at Wright-Patterson AFB.[3]

Value of Partnership Intermediaries

Due to several inherent strengths, the partnership intermediary approach has proven to be effective in facilitating technology transfer between DoD labs and the private sector. One major strength is that partnership intermediaries can function as objective, third-party brokers. DoD's agency-wide PIs are centrally funded and do not charge user fees to either DoD labs or companies for their services. In addition, these organizations do not have a financial interest in the technology transfer agreements that they facilitate. As a result, they are perceived as neutral parties whose motive is to achieve "win-win" agreements between DoD and industry. This helps them to facilitate communications between DoD labs and companies as well as solve problems that arise during the establishment of technology transfer agreements.[3]

In terms of their specific value to DoD labs, partnership intermediaries can engage in proactive, highly focused, and sustained marketing of lab technologies, capabilities, and needs. They can follow up on leads that lab personnel don't have the time to pursue. They can help DoD lab personnel to understand the commercial value of their technology. By actively helping companies to establish high-quality CRADA statements of work (SOWs) and licensing applications, including commercialization plans, they can ensure that lab technology transfer and legal personnel do not have to review incomplete or substandard documents. Finally, because they work with many different DoD labs, partnership intermediaries are able to spread "best practices" and innovative approaches to technology transfer across the DoD lab system. This helps to improve the efficiency and quality of DoD technology transfer.[3]

In terms of their value to industry, PIs help companies find innovative DoD technology, R&D, or business opportunities. They help make government "red tape" invisible through facilitating companies' interactions with the labs and helping companies to understand lab requirements and government regulations. They also can help conduct market research to establish the value of licensable technologies. As previously mentioned, they can help companies to develop viable license applications and commercialization plans.

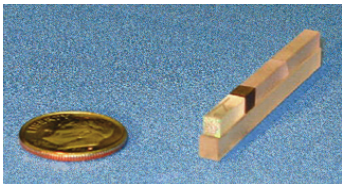

Figure 2. The monoblock laser is an enabling technology for advanced rangefinding and target acquisition capabilities.

In short, PIs provide valuable technology "matchmaking" services between DoD labs and companies. They help to identify technology transfer opportunities, link together prospective partners, facilitate communications, provide troubleshooting, and serve as mediators throughout the technology-transfer process.

EXAMPLE OF WEAPON-RELATED TECHNOLOGY TRANSFER

The monoblock laser (see Figure 2) is a good example of technology transfer's value in transitioning innovative new technology to

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Figure 3. The STORM unit in action. The monoblock laser improves warfighter capabilities and force projection.

DoD weapon systems. This solid-state laser, which is only about 2 inches long, significantly reduces the size, weight, energy consumption, and versatility of DoD laser sighting and rangefinding systems. Because of its simple design, with no moving parts, this laser is far more rugged and less expensive to manufacture than its predecessors. Its small size and affordability enables laser rangefinders to be mounted on individual soldier rifles – a capability not previously possible. This innovation is the enabling technology for advanced rangefinding and target acquisition capabilities that are being widely deployed on individual and crew-served weapon systems in Iraq and Afghanistan.

The monoblock laser was invented by researchers at the Army Night Vision Laboratory in Fort Belvoir, Virginia. It subsequently was developed with assistance from Scientific Materials Corporation in Bozeman, Montana, which has long been internationally recognized for its ultra-high-purity laser crystals. Scientific Materials grew the crystals and fabricated the laser rod components for the monoblock laser.

In 2003, following successful testing of the monoblock laser and its patenting by the Army, TechLink helped Scientific Materials to license this invention from the Army Night Vision Laboratory. TechLink's companion MilTech program assisted Scientific Materials with final product development. One major challenge was making the system rugged enough to withstand prolonged use on weapon systems, which – in addition to the normal rigors of battlefield use – are subject to repeated sharp jolts from firing operations.

To meet DoD demand for the monoblock laser and transition this innovative technology to the US warfighter as rapidly and cost-effectively as possible, TechLink's MilTech program helped Scientific Materials* to design and implement an efficient production system. This system employs best practices in inventory management, supply chain qualification, lean manufacturing, and quality control.

The monoblock is currently the enabling component for the AN/PSQ-23 Small Tactical Optical Rifle Mounted (STORM) micro-Laser Range Finder (mLRF, see Figure 3). The STORM integrates a laser rangefinder, digital magnetic compass, visible aiming laser, infrared aiming laser, and infrared illuminator into a single compact, light-weight package. This device allows precise weapon aiming, target acquisition, and target area illumination under any lighting conditions. It enables warfighters to accurately determine far target locations as well as address targets with both direct fire and indirect fire weapon systems. The STORM is currently deployed on individual weapon systems, such as the M4 and M16, as well as crew-served weapon systems on armored fighting vehicles, such as the M240 and M2. The monoblock laser technology is now being developed for deployment on other major weapon systems including aerial platforms.

CONCLUSION

The monoblock laser example illustrates how technology transfer provides a key way for DoD to both benefit from the innovations developed in its own R&D labs and leverage the capabilities and assets of the private sector. Increasingly, technology transfer will be one of the key ways that DoD acquires innovative technology for the US warfighter. The coming era is likely to be characterized by asymmetrical warfare and a declining internal DoD R&D budget. In such an environment, technology-transfer partnerships with the private sector – particularly with innovative non-traditional defense contractors – will provide an important way for the US military to maintain its global competitive advantage.

NOTE & REFERENCES

* Scientific Materials is now a division of FLIR Systems, Inc.

[1] Department of Defense Directive, Number 5535.3, "SUBJECT: DoD Domestic Technology Transfer (T2) Program," May 21, 1999.
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Dr. Will Swearingen has managed technology development and technology transfer programs for more than 16 years. Since 2000, he has served as the Executive Director of TechLink, a federally funded technology transfer partnership intermediary at Montana State University. TechLink helps the Department of Defense (DoD) and other federal agencies to license their technology to industry and to find productive cooperative research and technology development partners. Dr. Swearingen has played a key role in transforming TechLink into a nationally recognized technology transfer organization. TechLink has brokered over 600 agreements between federal labs and industry. In addition, over the past six years, it has helped to facilitate over third of all DoD licensing agreements with industry nationwide. TechLink provides nearly a 4:1 return on investment to DoD from its technology transfer activities. Dr. Swearingen has a PhD in geography from the University of Texas at Austin and conducted postdoctoral research at Stanford University.

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We provide answers to customers looking for copies of reports, legacy data and information, or engineering consulting services.

Below are just a few of the numerous inquiries submitted to us each month:

Are there any data that defines the minimum set of critical skills needed by a program office technical staff to properly execute a disciplined systems engineering process?

Could you assist in finding the "Net Explosive Weight" (NEW) of the Stinger missile to use for explosive safety calculations?

What technology modifications are called for in the Apache BLK 111 upgrade program?

In order to develop an appropriate environmental stress screening (ESS) profile (or highly accelerated stress screening – HASS) for power supplies, how often and when is it recommended to turn the supplies on and off to test them and why? Is it recommended voltage is monitored 100% of the time when transitioning cold to hot?

Can you provide information (e.g., perform a document search) on spectral intensities of bullets?

Is the Latvian 120mm Mortar NATO Standard? If not would their ammunition be NATO Standard?

Can you provide information concerning where/how to locate/access databases containing measures of effectiveness of real-world applications of the DoD's directed energy, non-lethal weapons technologies (particularly lasers)?

Is Dechlorane Plus (tradename of occidential chemical CAS # 13560-889-9) used as a fire retardant in the liners of DoD rocket motors?

Can you provide information on available IED training resources?

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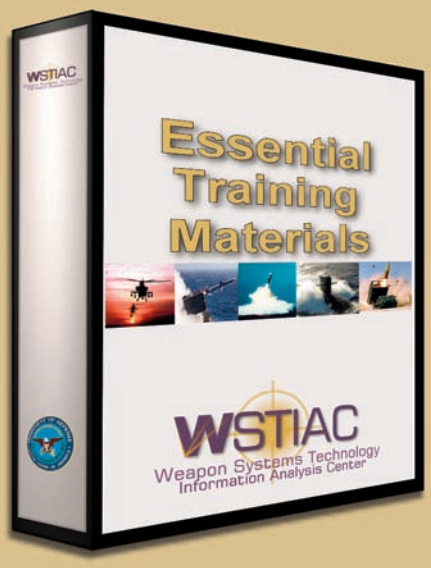

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Iraq and the AC–130:
Gunships Unleashed

Major Robert J. Seifert
US Air Force

The article below, originally published in the Joint Force Quarterly, was written to improve AC-130 tactics in the Iraq theater of operations. Not surprisingly, technology and hardware play an enormous role in present gunship tactics and are the foundation for the gunship's inherent strengths and weaknesses. Tactics do not change easily in today's Air Force and improvements in technology and hardware can be even more difficult. The Vietnam War saw the invention of the side firing gunship (AC-47), two entirely new versions of the gunship (AC-119 and AC-130) and a mind boggling improvement in sensors and firepower in less than eight years. From eyeballs to electro-optical sensors and 7.62 caliber miniguns to 105 mm howitzers, Air Force personnel and contractors set a benchmark for wartime innovation.

Partially responsible for the less than optimum tactics in Iraq is the lack of knowledge of the gunship's technological advantage in irregular warfare. Deceptively simple and mostly limited to the niche role of special operations close air support, few see past the destructive capability of the rapid fire 105 mm howitzer. Perfectly suited though for the insurgent fight is the 40 mm Bofors cannon. Able to strike a target with a single 2.5 lb HE warhead with ten seconds notice for hours at a time, the gunship carries a warhead equivalent to one carried by an individual dismounted soldier. Equally unique is the steep trajectory of gunship rounds that nearly eliminates ricochets and inadvertent strikes of surrounding urban structures.

Take special note of the first sortie described in the article, and carefully consider the air asset, which was enroute to an unrelated tasking at the time, that finds and sorts hostile insurgents. The gunship subsequently notified the engaged units' command and control before the unit itself could call for help. Persistent, incredibly aware, and able to strike with a single 40 mm round, the technology and hardware behind the gunship cause America's most elite infantry units to be very wary of a mission that doesn't have its support.

Giving great hope to gunship advocates is the recently announced plan to procure the AC-27 "Stinger" gunship. Much smaller and less expensive than the AC-130, its creation has the potential to revolutionize gunship employment and the Air Force's contribution to irregular warfare. The AC-27's substantially lower cost and reduced crew and signature will go a long way to ease the risk aversion ever present since an AC-130 was shot down in the first Gulf War. It is also quite likely that a substantially cheaper gunship will result in US marines and soldiers determining that what's practically mandatory for America's special forces units should be mandatory for all infantry units. In the end, tomorrow's gunship tactics and combat effectiveness will only be limited by the skill and flexibility of her crews and the technology and hardware produced by today's scientists and engineers. – Major Seifert

Slayer 74, an AC–130U side-firing gunship, was en route to Fallujah, Iraq, on October 5, 2003, to work with a joint terminal air controller (JTAC) from the 82d Airborne Division on a routine countermortar mission. Approximately 5 minutes from Fallujah, the pilot, equipped with night-vision goggles, noticed surface-to-surface fire through the small window by his left foot. He immediately rolled into a 20-degree left bank and talked his infrared and all low light level television (TV) sensor operators onto the tracers. In less than 30 seconds, they had identified stationary U.S. military vehicles and several suspicious individuals fleeing the area.

Already in contact with the JTAC for the upcoming mission, the gunship navigator notified him of the likely insurgent attack, the precise coordinates of the attack, and the fact that the gunship was tracking the fleeing individuals in an unpopulated area. Within 2 minutes, an attack was confirmed on friendly forces at the location passed by the gunship, and Slayer was cleared to engage the enemy force. Only seconds away from being hit with a 105-millimeter (mm) warhead, the fleeing insurgents joined several personnel and their vehicle, prompting a request for further guidance from the JTAC. The JTAC Army commander said to hold fire and to track the car while he assembled both a helicopter and ground quick-reaction force. With 3 hours of loiter time, the infrared and TV operators patiently tracked the insurgents as they drove off. The car traveled to a house where some of the insurgents got into a second vehicle and then proceeded to three other houses, depositing accomplices at all houses and a suspicious coffin-sized box at one.

With a flight of Army OH–58 Kiowa helicopters, two A–10s, and a Joint Surveillance Target Attack Radar System (JSTARS) assisting, the gunship crew kept a simultaneous watch on the four houses and two vehicles as they waited approximately 2 hours for the quick-reaction force to be formed, briefed, and driven to the first two insurgent compounds. Wanting maximum time on station for the compound assaults, the gunship departed for aerial refueling, leaving the A–10s and OH–58s on scene. Returning in less than 30 minutes from the KC–135 and now with 4 hours of playtime, Slayer provided armed escort to the two quick-reaction forces and covered the armed assault of the four insurgent houses over the next 3 hours. Those assaults resulted in 15 insurgents captured, 4 anticoalition houses identified and exploited, and 12 rocket-propelled grenades and AK–47s recovered from the suspicious box that Slayer witnessed the insurgents burying. The infrared operator actually walked the troopers to the location of the box and told them where to start digging.[1]

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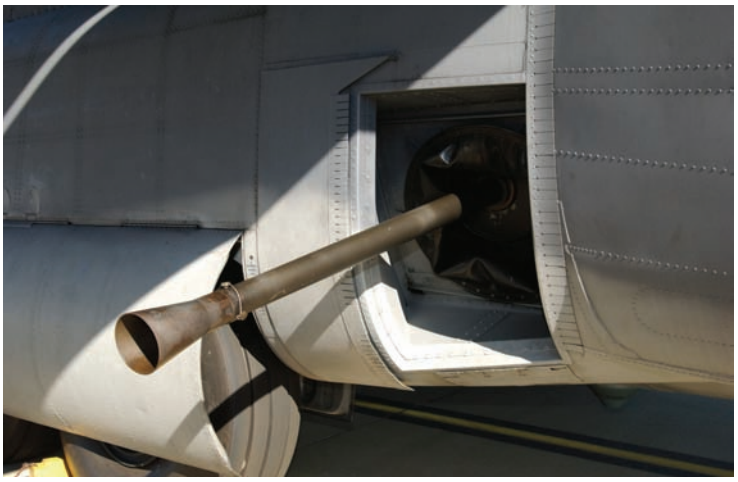


The AC-130 40mm Bofors cannon. (Photo courtesy of Robert J. Seifert)

Although a relatively minor setback to the insurgent cause in Iraq, this defeat at the hands of the AC–130 was undoubtedly devastating in the psychological effect of an apparently all-knowing American force able to strike with speed, precision, and minimum force. More importantly, it provoked the AC–130 pilot, the present author, to begin questioning what Carl von Clausewitz would likely call the "routine methods" of gunship employment at the highest level.[2]

The purpose of this paper is to save American lives and improve the chances of a successful outcome in Iraq. Costly and demoralizing attacks continue unabated against coalition and Iraqi ground forces. Working hard to support these forces are AC–130 gunships and crews. They fly every night in Iraq but rarely identify a single insurgent due to the inefficient manner in which they are requested by the Army and employed by the Air Force. This article shows how a simple yet fundamental change in AC–130 employment can kill or capture more insurgents, save friendly lives, and improve prospects for coalition success.

PRESENT EMPLOYMENT

Close air support is the present mission of the AC–130 in Iraq.[3] Night after night, at least one AC–130 launches to fulfill one or more air support requests (ASRs). The ASRs are prioritized and approved by the Joint Special Operations Air Component, which is the air component of the Combined Forces Special Operations Component commander who exercises operational control of the AC–130. The organizations supported are often individual Special Operations Forces (SOF) units with the remainder of AC–130 support going to conventional Army, Marine, and coalition regiments and brigades. The SOF teams usually have a defined operation for the AC–130 to support, and the conventional units usually have the AC–130 searching for insurgents in its individual brigade or regiment area of operations. A typical mission has the AC–130 supporting a single brigade's ASRs followed by aerial refueling and another 2 hours with another brigade or SOF team. While well intentioned, this method of employment does not fully exploit the great potential of the AC–130 to hunt and kill insurgents, nor does it benefit from lessons learned in aerial conflict over the past 60 years.

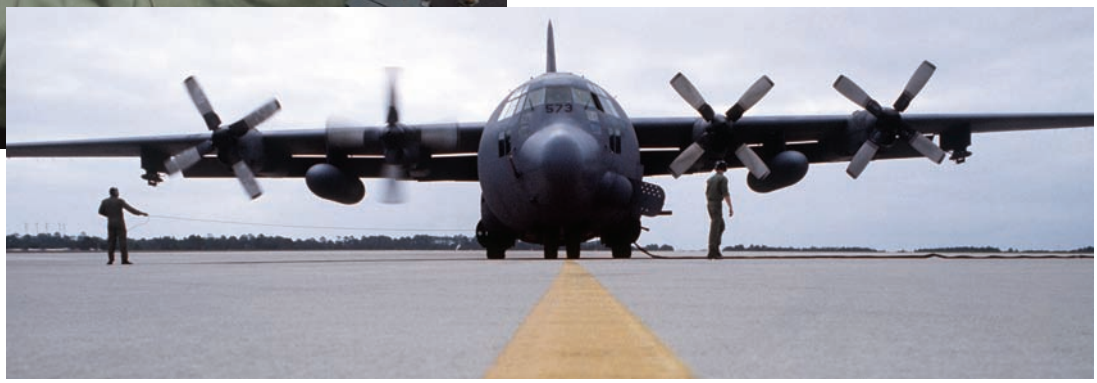
Field Manual 100–20. In North Africa, in the early months of World War II, ground commanders insisted on dedicated defensive umbrellas, which Airmen derisively labeled as "penny packets." This misuse of offensive-minded Airmen and their aircraft was partially responsible for the significant Allied losses at the Kasserine Pass in Tunisia in 1943 and contributed to the publication of War Department Field Manual (FM) 100–20, Command and Employment of Air Power. Signed into doctrine by General of the Army George C. Marshall, it has been called the most striking policy statement in Air Force history. Besides stating that ground and air forces were coequal, this doctrinal watershed demanded the centralized command of air forces, which has been accepted by ground and air forces after years of rigorous debate.[4]

Today's AC–130 defensive umbrella of individual ground units resembles the penny packets of the North African desert. Present gunship employment methods require individual ground units to submit an ASR that details the time, location, and reason for the requested support. If approved, the gunship shows up on time for the appointed duration. It is a convenient way to employ the gunship, but a comparison of the highly effective sortie at the beginning of this

AC-130 gunner scans ground for threats. (Photo taken by Denise Boyd and provided courtesy of US Air Force)

AC-130U Spooky gunship (Photo courtesy of US Air Force)

Airman uses weapons control booth onboard AC-130U Spooky gunship to target and fire 105mm howitzer on practice range. (Photo taken by Greg L. Davis and provided courtesy of US Air Force)



AC-130H preparing for takeoff. (Photo taken by Susan Foreman and provided courtesy of US Air Force)

article and the ineffective sortie synopsis that follows should help to explain the need for a review of present gunship employment.

Tasked to Al Hayy. Ten months after finding and helping to capture the 15 insurgents and their weapons cache while en route to their assigned mission, a subsequent sortie sent the author to support a ground unit in Al Hayy for approximately 5 hours, with an aerial refueling in the middle. The second uprising of the Mahdi militia was in full swing in southern Iraq, and the crew was optimistic that an opportunity to engage insurgents would present itself. Unfortunately, 15 minutes after arrival on station, it was obvious to the crew that the chance of engaging insurgents in Al Hayy was slim to none. The two visual sensors and pilots (equipped with night-vision goggles) had searched the town for activity, located the friendly positions, and received a situation report from the JTAC that revealed an absence of observed insurgent activity and no plans for friendly offensive operations. With no option but to stay and wait for the scheduled tanker rendezvous time, the infrared and TV sensor operators repeatedly searched the town for anything remotely interesting that could be passed from the navigator to the local tactical air controller.

The trip to the tanker and the subsequent aerial refueling were uneventful until the return leg to Al Hayy, which happened to pass just north of the city of Najaf. Najaf was the location and inspiration of the August uprising but was without a gunship due to either a failure to submit a support request or a determination that the Najaf ground force commander's need was not as compelling as those units in Al Hayy and Fallujah. Be that as it may, the crew swung into action when the copilot spotted significant surface-to-surface fire in the city, which surely indicated that the Marines in Najaf were under attack.

Having worked with the Marines there previously, it took less than a minute to get their JTAC on the radio and inform him of the gunship crew's situational awareness and nearby location. The JTAC confirmed that he had troops in contact and asked for immediate assistance. Unfortunately, the aircraft commander had to notify him of his inability to assist due to assignment to another unit. The aircraft commander told the JTAC to make a request immediately to the Air Support Operations Center (ASOC) and told him that he would also call to try and get released from his Al Hayy tasking.

Unaware as to how quiet Al Hayy had been, and probably due to the fact that the Marines' request for help had to travel from the ASOC to the Combined Air Operations Center to the Special Operations Liaison Element to the Joint Special Operations Air Component and then to the Air Force Special Operations Detachment, the decision was made for the gunship already tasked to the town of Al Hayy to complete its assigned mission. The gunship assigned to Fallujah, 30 minutes away, would be diverted to support the Marines as it was almost complete with its current mission. The author kept the frequency open with the Marines, hoping for a change in tasking, but the last call heard was the same JTAC clearing medical evacuation helicopters into his airspace to pick up the very Marines that the pilot and copilot had witnessed being attacked.

Due to the continued lack of insurgent activity at Al Hayy, the gunship was ordered home and landed with 3 hours of fuel in the tanks. Adding to the frustration was the fact that this sortie was the fourth night in a row "supporting" quiescent ASRs. The crew did not engage a single insurgent on any of the five sorties, even though August 2004 was one of the most violent months of the insurgency.

PAST EMPLOYMENTS

Gunships on Call. History supports the consideration of a different employment technique for Iraq's gunships. Early in the Vietnam War and before the AC–130 was born, the AC–47 gunship arrived in-the-

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ater with what was then the 4th Air Commando Squadron. Within the first year of operation in South Vietnam, "Spooky" had defended 500 outposts and in a single 90-day period claimed to have broken up 166 enemy night attacks.[5] Allegedly, the enemy was so afraid of the first gunships that they were ordered not to fire at what they thought was a fire-breathing beast that might become even angrier.

The gunships in 1966 did not accomplish this feat or earn this reputation by being tethered to a single ground unit and waiting for it to be attacked, but rather by being on call for whichever outpost needed them most. Every outpost was in contact with higher headquarters, and as soon as an outpost was attacked, an AC–47 was diverted to its position.[6] To guarantee a particular outpost was never attacked would have required a dedicated gunship all night, but necessity detailed it to a centralized location, on call for any unit experiencing an insurgent attack (an employment more in line with the intent of FM 100–20).

Lieutenant General Julian Ewell, USA, commander of II Field Force, Vietnam, between April 1969 and April 1970, stressed the morale effects that the gunships had for an infantryman: "It gave him a lot of assurance and security to know that if he got in a tight spot, a gunship would be there in fifteen or twenty minutes and start hosing off the countryside." General Ewell did not say that the gunship was reassuring overhead, but rather that it was reassuring knowing that it could be there in "15 or 20 minutes"[7] if needed. The infantryman in Iraq does not have the same assurance because the AC–130 is trammeled to a single ground unit for a prescribed period that is usually determined the day prior—a fundamental violation of the doctrine of centralized control.

AC-130U cockpit. (Photo courtesy of Robert J. Seifert)

The Ho Chi Minh Trail. As the Vietnam War progressed and the unique and effective abilities of the gunship became apparent, the Air Force created the more capable AC–130 gunship and began to use it in the interdiction role. AC–130s were specifically used to roam the Ho Chi Minh Trail hunting for trucks under the thick jungle canopy that were carrying supplies needed by the guerrillas in the South. To show the effectiveness of the AC–130 compared to conventional attack aircraft, one only has to look at the number of truck kills per sortie. Trucks moved most easily in the winter months, and in the winter of 1971–1972, AC–130s killed or damaged 8.3 trucks per sortie compared to fighter-bombers, which averaged 0.29 trucks killed or damaged per sortie.[8] Allegedly, North Vietnamese truck drivers were actually handcuffed to their vehicles to keep them from abandoning their trucks at the first sign of an AC–130.

So what does killing trucks in the jungles of Vietnam have to do with killing insurgents in Iraq? Both trucks and insurgents are fleeting and difficult-to-kill targets, yet the earliest version of the AC–130 excelled at killing trucks and their drivers. It did so in a disproportionate manner to any other asset and could do the same against the insurgents in Iraq. The AC–130s that killed over 10,000 trucks on the Ho Chi Minh Trail were not tied to one Army unit but rather were tasked to kill trucks. Task the present-day and much improved AC–130 to hunt insurgents rather than provide 2-hour blocks of individual unit overwatch, and one can expect the same aweinspiring results as the Vietnam-era gunships. General Henry "Hap" Arnold's words are as relevant to the gunships over Iraq as they were to the B–17s, P–47s, and P–51s of World War II: "Offense is the essence of airpower."[9]

Time-sensitive Targeting of Insurgents. There are more recent examples of AC–130s being used flexibly versus the present inefficient overwatch of individual ground units for prescribed periods. The Air Force realized its lack of success in preventing Scud attacks on Israeli population centers in the first Gulf War and created a combined air and ground force to neutralize the Scud threat in the second Gulf War. Both air and ground forces had assigned areas to search and were ready to execute highly refined and practiced procedures designed to kill Scuds quickly, along with their support equipment and personnel. All air and ground assets were focused on preventing Scud launches, and there was a prioritized list of targets, with a raised Scud (that is, ready to launch) at the top of the list. Whether detected by ground, air, or space platforms, the nearest attack aircraft was immediately pushed by command and control from its assigned search area to destroy the target.

The Air Force conducted three exercises at Nellis Air Force Base before the war to practice these procedures and helped ensure zero Scud attacks on Israel.[10] The Sunni Triangle is much smaller than the western Iraqi desert, and the continuing attacks and loss of lives in Iraq are having a strategic impact. Taking a similar plan and a comparable focus in stopping insurgent attacks is definitely a course of action long overdue.

PROPOSED EMPLOYMENT

Gunships on Call Again. Today's AC–130 is far more effective than the AC–47s of yesteryear. Able to hunt, cover the critical minutes of offensive operations, and simultaneously be on call, only two gunships would be required each night in the Sunni Triangle. Helping to find the insurgents are the JTACs, who should be in near contact with every one of their ground units and in constant contact with either the gunship or the Air Support Operations Center. At a minimum, the AC–130 checks in with each brigade JTAC on the AC–130 frequency as it sequentially passes through each brigade's area of operations during the course of an evening. It passes on any interesting information and requests the latest intelligence. With the range of the gunship radio, the aircraft is in continuous contact with several brigades at once. This allows near-immediate targeting of insurgents as they make contact with coalition forces. This nightly patrol and single frequency also allow both SOF and conventional units to count on gunship coverage for timesensitive raids requiring immediate exe-

cution. Present employment methods require several hours notice to guarantee gunship coverage of a SOF or conventional raid.

For those units out of gunship radio range, the ASOC would take their insurgent "point-outs" as they can now, but under the author's plan, they would always pass them to the gunship on either the dedicated gunship frequency or a dedicated long-range frequency. The Air Support Operations Center is responsible for assigning the sensor-equipped fighters to work in conjunction with the two AC–130s as they patrol the Triangle, increasing the effectiveness of both gunships and fighters. The high speed of the fighters and their ability to capture insurgents with their sensor suite would ensure a response time within minutes, even when the gunship has simultaneous insurgent point-outs. The AC–130 can use its remaining radios to talk directly to those units engaged with the enemy. With seven radios, the gunship crew has no problem monitoring the many command and control agencies with radios to spare for those actually in contact.

The result of this proposed change would put one of two nightly gunships no more than 20 minutes from every coalition soldier in the Sunni Triangle. A gunship-assigned fighter cuts the sensor-on-scene time to no more than 10 minutes. Every JTAC in the Triangle would talk to an AC–130 crew several times per night versus several times per month.

AC-47 flies mission over South Vietnam. (Photo courtesy of US Air Force)

Finding the Insurgents. Coalition ground forces must create a list of insurgent hot spots and request that gunships fly over these locations as often as possible. The list should include coalition bases, convoys, police stations, roadways infested with improvised explosive devices, patrols, and infrastructure. Individual Army and Marine units should include this information on their ASRs to the ASOC, which would generate new and more useful mission assignments for the AC–130 crews. These crews would then plan their route of flight using the latest intelligence on insurgent activity to improve the chances of finding insurgents in the act. This author stumbled on 3 insurgent ambushes during his most recent 25 sorties while en route to his mission assignments. The odds of finding insurgents every night in Iraq would be rather high if crews were actually tasked to hunt for them.

Neutralizing the Insurgents. Whether the AC–130 finds insurgents on its optimized flight plan or rushes to the aid of a friendly ground force, it has the ability to attack the insurgents nearly instantaneously when cleared by the JTAC and his ground force commander. It can do this because of its precise fire, low-yield munitions and ability to communicate and confer simultaneously with every level of theater Army, Air Force, Marine, and SOF command and control.

While immediate fire on the insurgents is often preferred, certain situations will require further analysis and preparation. The AC–130, with 4 hours of loiter time and the ability to refuel in air, can wait for a ground or heliborne quick-reaction force to be mustered to assist with the situation. These forces should be ready to move immediately, knowing the well-practiced ability of the AC–130 to vector small ground units to the target area quickly and safely. Once on scene, the quick-reaction force uses the situational awareness and precise firepower of the gunship to help assess the situation and neutralize the enemy, if required.

OUT OF OUR OODA LOOP

Presently, the insurgents are deep in our OODA loop (observe, orient, decide, act) — that is, our decision cycle—which helps to explain our lack of success in defeating them. Their civilian dress allows them to observe us at will and orient themselves to ensure maximum chance of success. They decide to attack when coalition forces are most vulnerable and usually depart before any coalition advantage in firepower or personnel can be brought to bear. Thus, it is just as the insurgent OODA loop is complete that coalition forces begin to run their loop: "Did anyone observe where that fire came from? Will there be more? Should we orient ourselves offensively or defensively? Do we decide to stay or run? Do we request an Army quick-reaction force or Air Force close air support, or can we attack the enemy ourselves?" Again, this all occurs after the insurgent OODA loop is complete, and their goal of yet another brazen attack on coalition forces has been met.

The proposed tactics would change the coalition OODA loop in the following manner: We have observed the enemy and know he often strikes anywhere in the Triangle—and the attack will be quick. Let us orient two gunships on flight paths optimized for search and communications connectivity and decide before the attack occurs that the gunship will be pushed immediately to attack or investigate any insurgents who might be caught in the act. Now 75 percent complete with their OODA loop, coalition forces eagerly wait for an attack to counter with their own attack. In many cases, the AC–130 will observe the enemy first and actually complete its OODA loop before the insurgents even know they have been acquired. Also in favor of the coalition is that their attack will be executed with an airborne artillery platform that is capable of communicating simultaneously with soldiers in the field, JTACs in their headquarters, and all command and control agencies upstream.

CENTER OF GRAVITY

Strategists yearn for a center of gravity to attack in order to crush the insurgency, and many claim there is none. They fail to see that the center of gravity is the individual insurgent and the location of his attack. For it is at that location alone, and only for a brief time, that the insurgent we struggle to define is an irrefutable enemy and a definable target. Strategists and tacticians both must look at each insurgent attack in the same light as our grandfathers looked at Germany's war industry. Unlike during World War II, there are only minutes to plan and strike, requiring that a plan already be in place. Focus the same effort in striking this fleeting center of gravity as was

used on the centers of gravity in World War II and coalition results are sure to improve.

When discussing centers of gravity in an insurgency, the civilian population is rightly considered one as well. Unlike other centers, though, it must be struck with legitimacy. The AC–130 tasked to strike insurgents in the act with individual 40mm rounds does a much better job of this than some of the present tactics that often hurt more than help the coalition cause.

IMPLEMENTATION

The Air Force, and specifically the AC–130, is working hard in Iraq but has yet to reach its full potential in helping to defeat the insurgency. Whether we measure insurgents killed per sortie flown or jet fuel burned, the Air Force will run out of sorties and fuel before Iraq runs out of insurgents, if present tactics are continued. A simple yet fundamental change in AC–130 tactics is needed and could start immediately with zero increase in aircraft and personnel. The change required can be easily explained by highlighting what the ground and air forces must do, respectively.

Ground Forces. The ground forces must stop demanding dedicated coverage of individual units for specified periods, except for the most unusual circumstances. Rather, they must ask for two AC–130s on patrol and on call for the night and ensure that every brigade JTAC is on frequency with the forces under him. JTACs must also pass updated enemy activity and anticipated friendly operations to allow the gunship crews to optimize their routing in order to be overhead as much as possible. When attacked by insurgents, ground forces should continue to react as they have been trained, but with one small exception: Troops in contact must report the insurgent activity whether they believe they can handle the situation or not. Finally, ground forces must have a standing helicopter and ground quick-reaction force ready to respond to situations where the culpability of insurgents is in doubt and where collateral damage is a concern.

Air Forces. The Air Force must focus on finding and neutralizing insurgents in conjunction with the ground forces. Commiting two AC–130s and available fighters and unmanned aerial systems to hunt for insurgents each night on a scheduled gunship frequency ensures that the majority of invaluable and limited AC–130 time is spent hunting, checking in with JTACs, and killing and capturing insurgents. Presently, gunships spend the majority of their time in transit to the Triangle and flying over a relatively small number of individual units for periods much longer than required or effective. As AC–130 crews and aircraft are limited, the Air Force must ensure that each crew has a maximum 12-hour crew day, which allows it to fly every other night and show at the same time each afternoon. This type of schedule ensures that well-rested crews are not forced to exceed their monthly flying hours limit, as they routinely do now.

Infrastructure, Command, and Control. The infrastructure already exists for those units out of touch with the AC–130 but wanting to point out insurgents. The ASOC is in place and already tasked to support ground forces needing help from air forces. The only difference would be how much more often the ground forces call and how rapidly the air forces respond. Command and control is also already in place, and personnel at some locations could be reduced by eliminating the prioritization of preplanned and immediate ASRs every night. Unlike the present system, the proposed command and control plan is simple, flexible, and fast reacting. The aircraft commander and crew determine their effectiveness at each target location and decide how long to stay by comparing the effectiveness of what they are presently doing versus hunting for insurgents, maneuvering friendly ground forces overhead, or responding to an insurgent point out from the ASOC or individual unit JTACs.

The final justification for implementation of this AC–130 plan is that it could start tomorrow. ASRs could provide the callsign and location of every brigade and regimental JTAC and would include their list of likely insurgent locations and offensive operations for the evening. All ASRs would be supported with the amount of time and effort determined by present enemy activity and offensive operations in progress versus yesterday's enemy activity and anticipated operations. All JTACs would be on a single frequency, and as the gunship checks in with each, the crew could emphasize the importance of immediate notification of any insurgent activity and the readiness of their unit's quick-reaction force to respond.

Finally, we should challenge aircrews to find as much insurgent activity as possible and strive to set a record for how many and how often each JTAC can be contacted in a single sortie. The lethality of the process is easily measured and improved first by measuring how fast the gunship gets word of insurgent activity and second by how fast it arrives on scene. Finally, we should measure AC–130 success by insurgents killed and captured rather than ASRs supported, and we should not stop improving the process until the last American warfighter leaves a free and stable Iraq.

NOTES

[1] The author flew all AC–130U sorties referenced in this article.

[2] James S. Corum and Wray R. Johnson, *Airpower in Small Wars: Fighting Insurgents and Terrorists* (Lawrence: University Press of Kansas, 2003), 274.

[3] The author flew his first Iraq AC–130 combat mission on March 21, 2003, and his final one on August 30, 2004. He has approximately 45 combat sorties in support of ground forces in Iraq. Much of the background information in this article comes from personal experience in 7 years of flying AC–130s and from conversations with other crewmembers returning from the Iraqi theater. Because the war in Iraq is ongoing, it must be realized that AC–130 tactics, techniques, and procedures there are evolving, and some information in this article might be outdated.

[4] Daniel R. Mortensen, *Airpower and Ground Armies* (Maxwell Air Force Base, AL: Air University Press, 1998), 93–140.

[5] Benjamin Franklin Cooling, ed., *Case Studies in the Development of Close Air Support* (Washington, DC: Office of Air Force History, 1990), 444.

[6] Ibid.

[7] Ibid.

[8] Eduard Mark, *Aerial Interdiction: Air Power and the Land Battle in Three American Wars* (Washington, DC: Center for Air Force History, 1994), 352.

[9] Charles M. Westenhoff, *Military Air Power: The Cadre Digest of Air Power Opinions and Thoughts* (Maxwell Air Force Base, AL: Air University Press, 1990), 110.

[10] The author participated in one of the exercises at Nellis Air Force Base in January 2004 and flew several AC–130 combat missions searching for Scuds in western Iraq in the first weeks of Operation *Iraqi Freedom*.

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